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Ikezawa

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(54) **BOBBIN AND COIL COMPONENT**

(71) Applicant: **TDK CORPORATION**, Tokyo (JP)

(72) Inventor: **Akira Ikezawa**, Tokyo (JP)

(73) Assignee: **TDK CORPORATION**, Tokyo (JP)

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(52) **U.S. Cl.**
CPC ***H01F 27/306*** (2013.01); *H01F 27/2847* (2013.01); *H01F 2027/2861* (2013.01)

(58) **Field of Classification Search**
CPC ... H01F 27/325; H01F 27/324; H01F 27/292; H01F 5/02; H01F 22/2847; H01F 17/041
See application file for complete search history.

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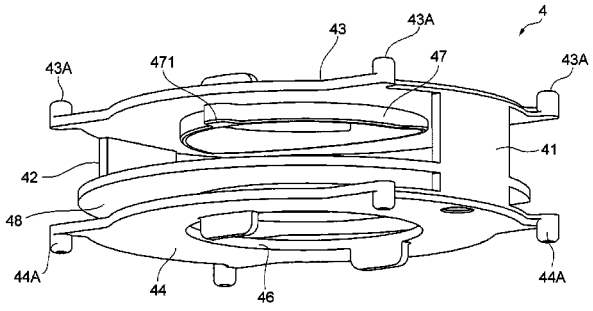
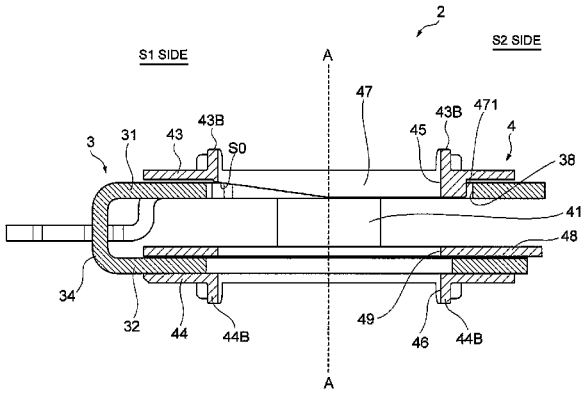
Primary Examiner — Alexander Talpalatski
Assistant Examiner — Joselito Baisa
(74) *Attorney, Agent, or Firm* — Oliff PLC

(57) **ABSTRACT**

To improve the insulation property of a coil winding wire without increasing the number of components. In a case where a coil winding wire **3** is inserted into a region formed by two side wall portions **41** and **42** and two connection portions **43** and **44** and this result is sandwiched between magnetic core members **6**A and **6**B, it is possible to prevent the two side wall portions **41** and **42** from contacting the coil winding wire **3** and the outer electronic components. Further, since the coil winding wire **3** is sandwiched by the connection portion **42** formed at the upper surface side of the coil winding wire **3** and the connection portion **44** formed at the lower surface side thereof from the upper and lower surfaces of the coil winding wire, the insulation property with respect to other electronic components in the up and down direction is also maintained.

7 Claims, 11 Drawing Sheets





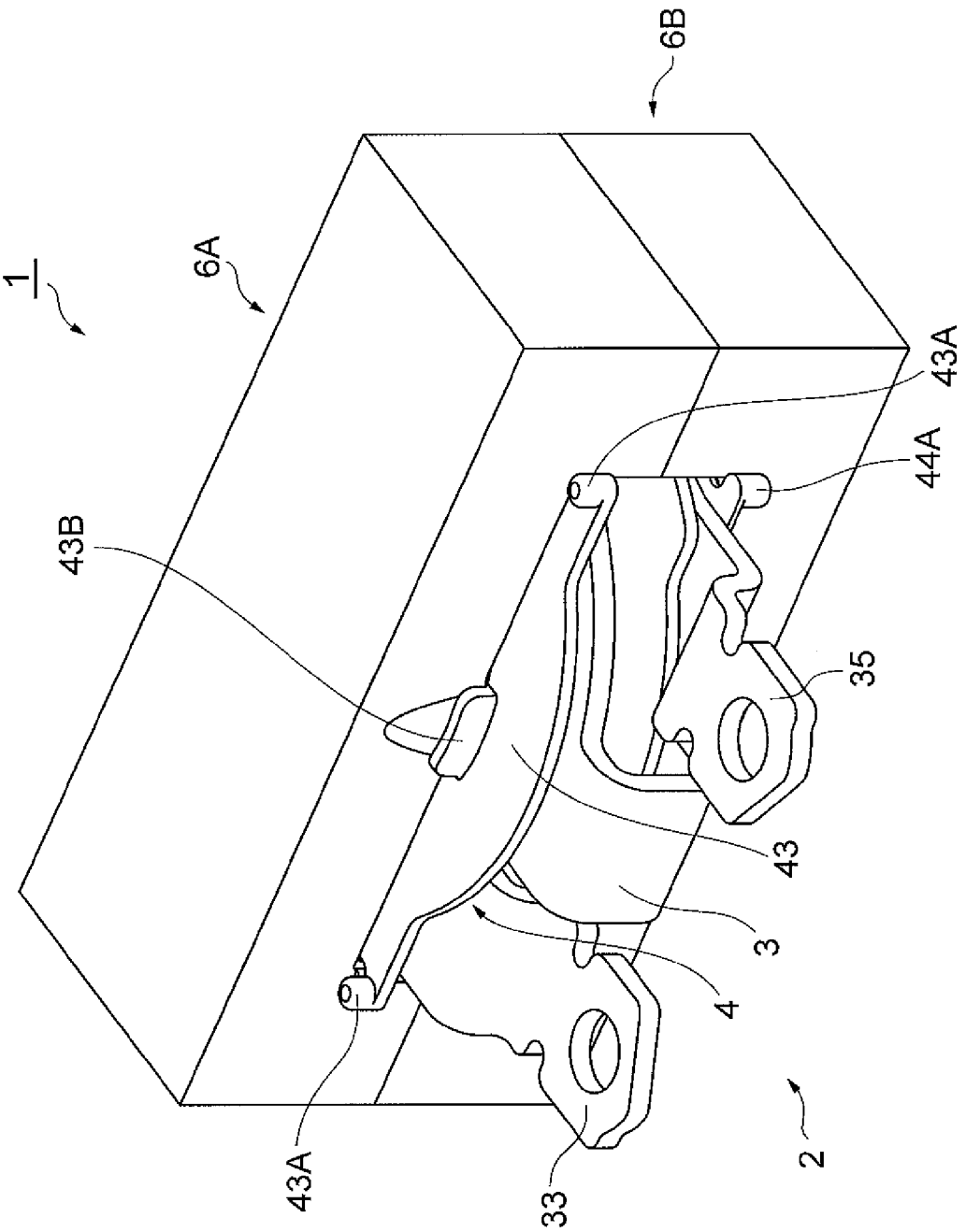


Fig.1

Fig.2

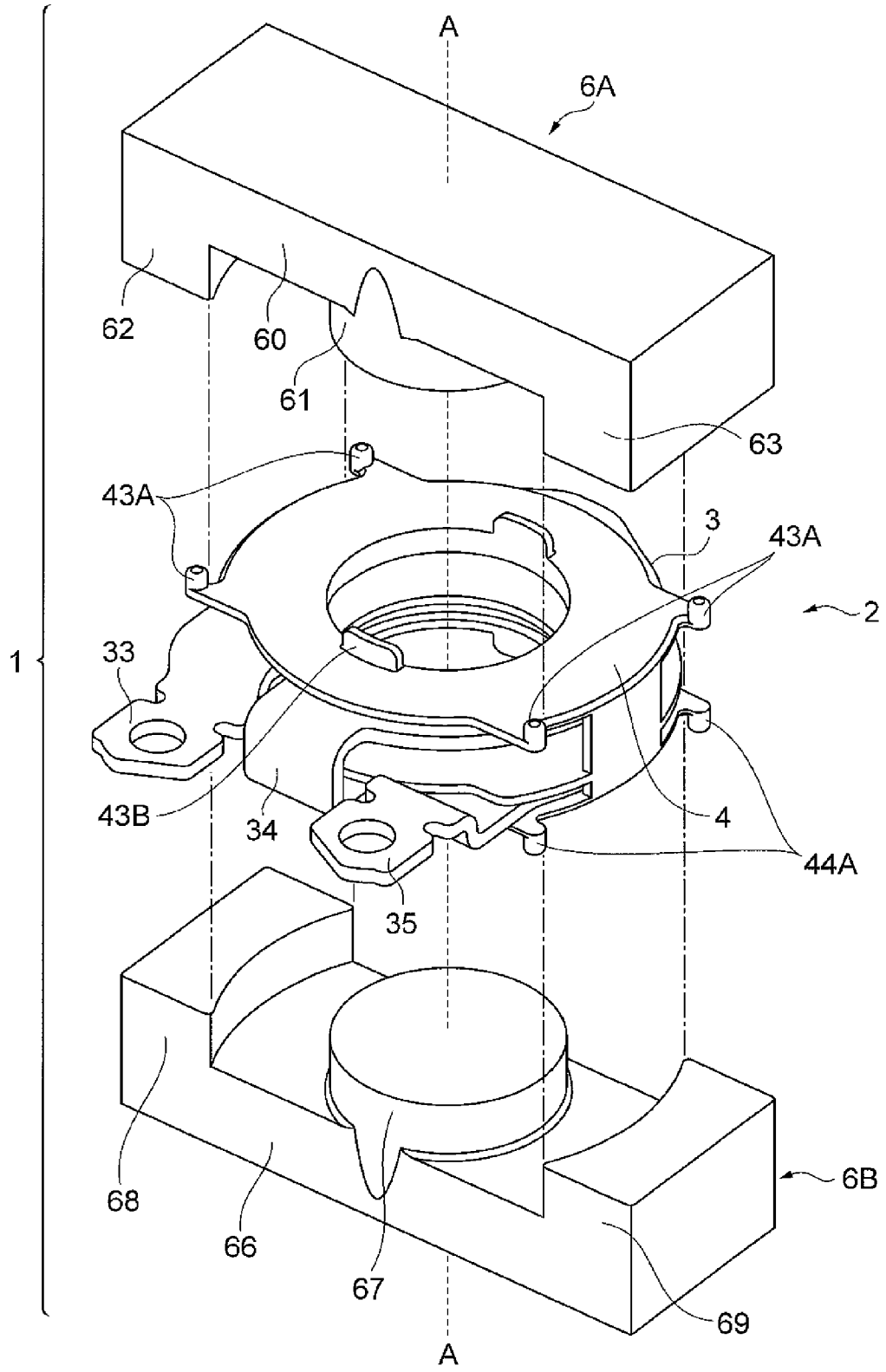


Fig.3

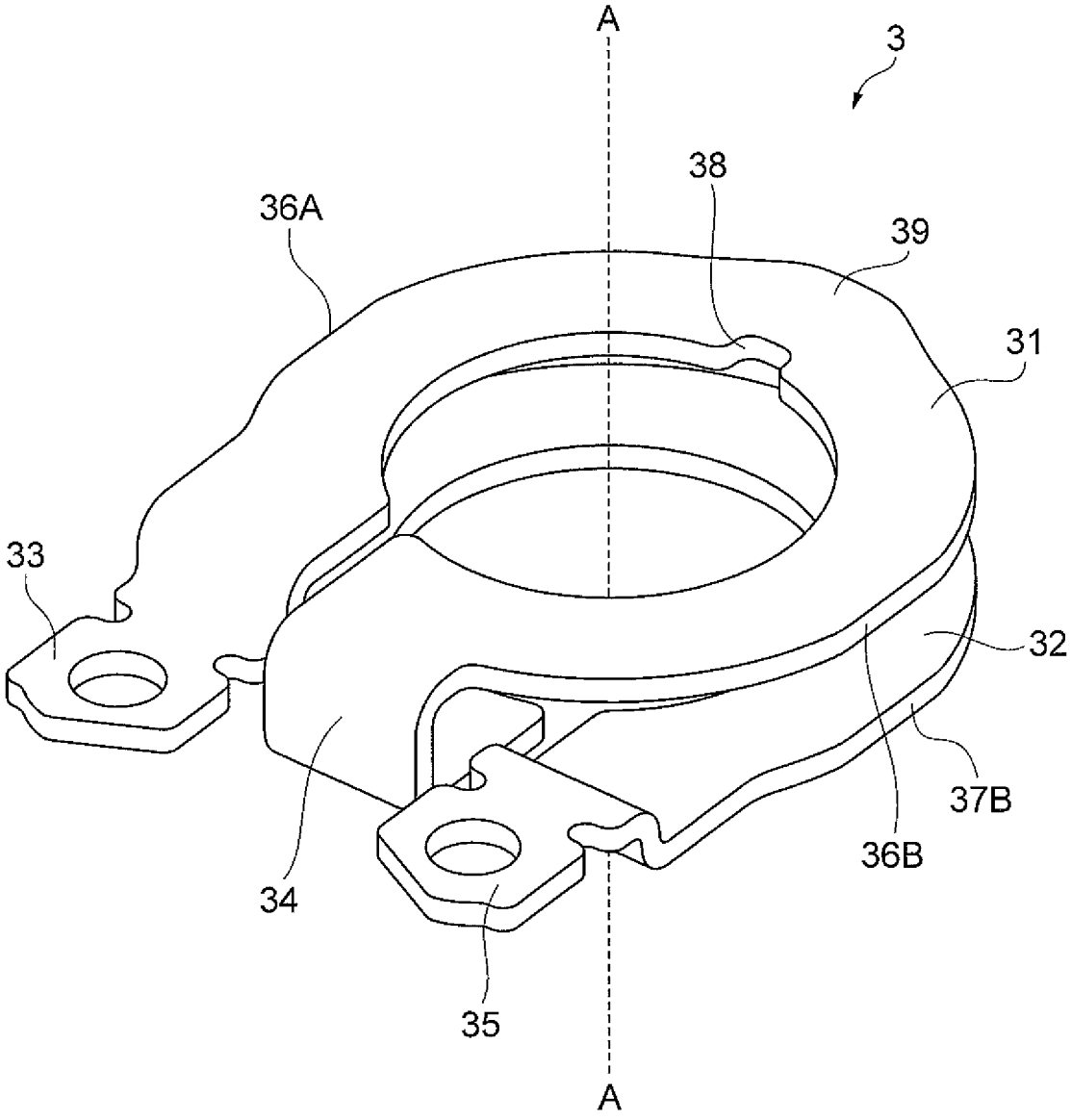


FIG. 4(A)

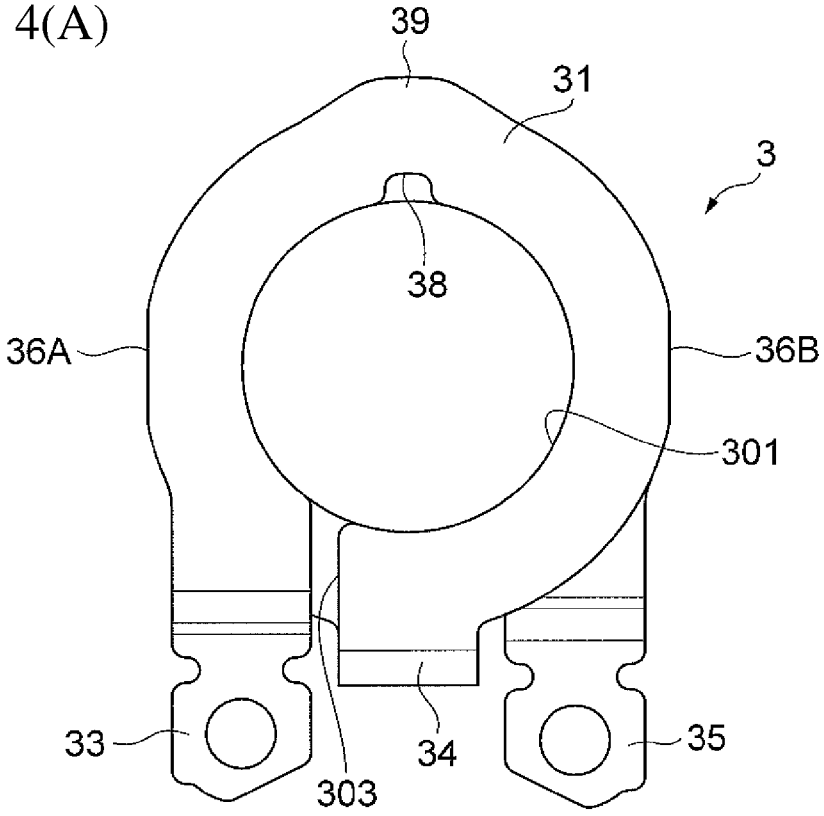


FIG. 4(B)

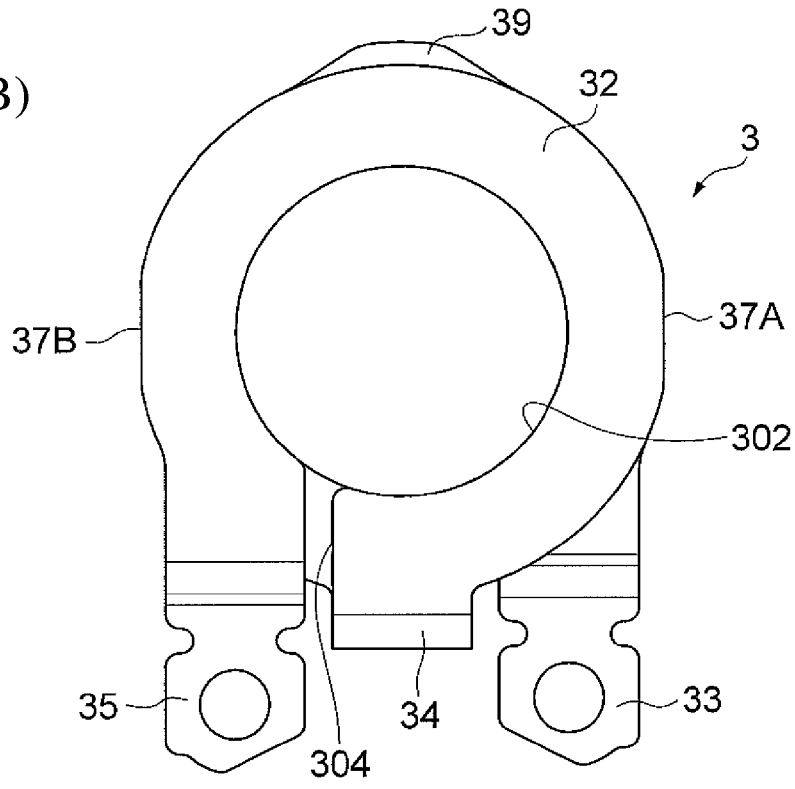


FIG. 5(A)

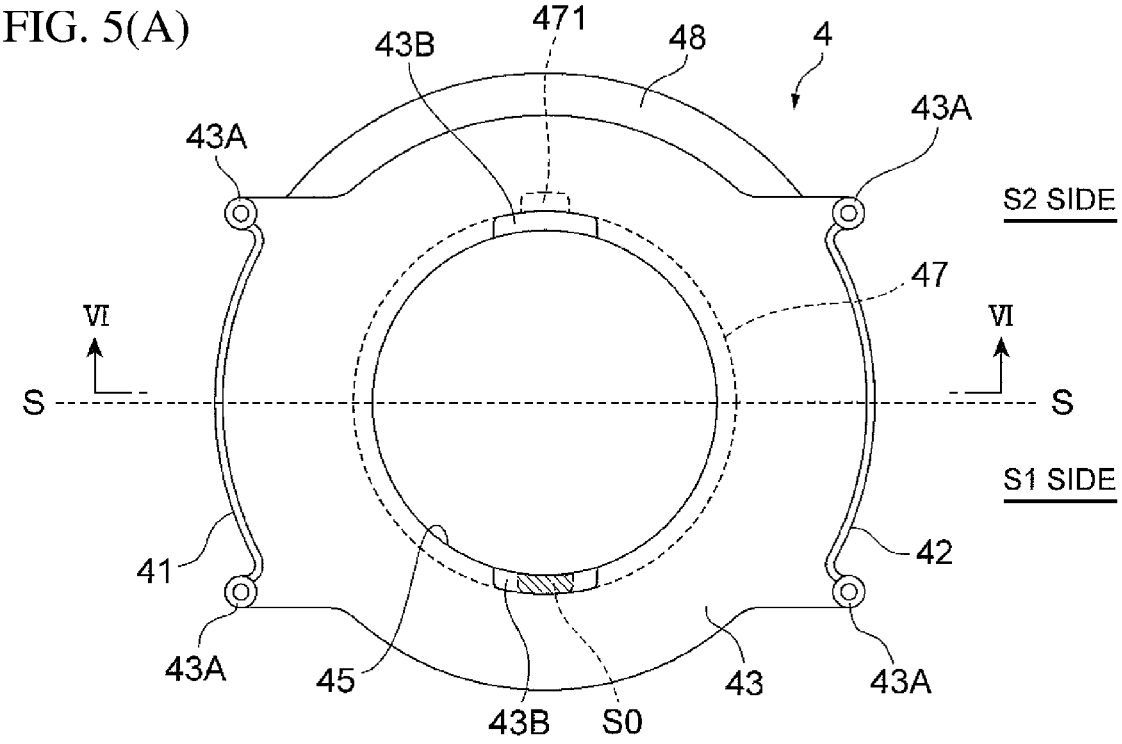
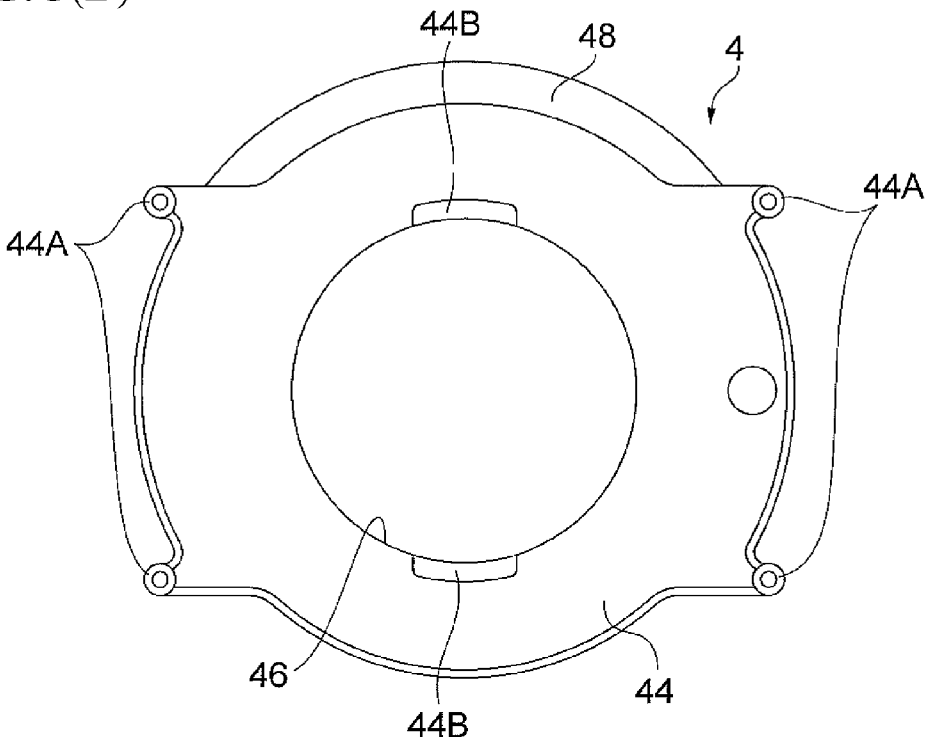

471
43B
48
4
43A
43A
S2 SIDE
47
VI
VI
S
S
S1 SIDE
41
42
43A
45
43
43A
43B
S0

FIG. 5(B)


44B
48
4
44A
44A
46
44
44B

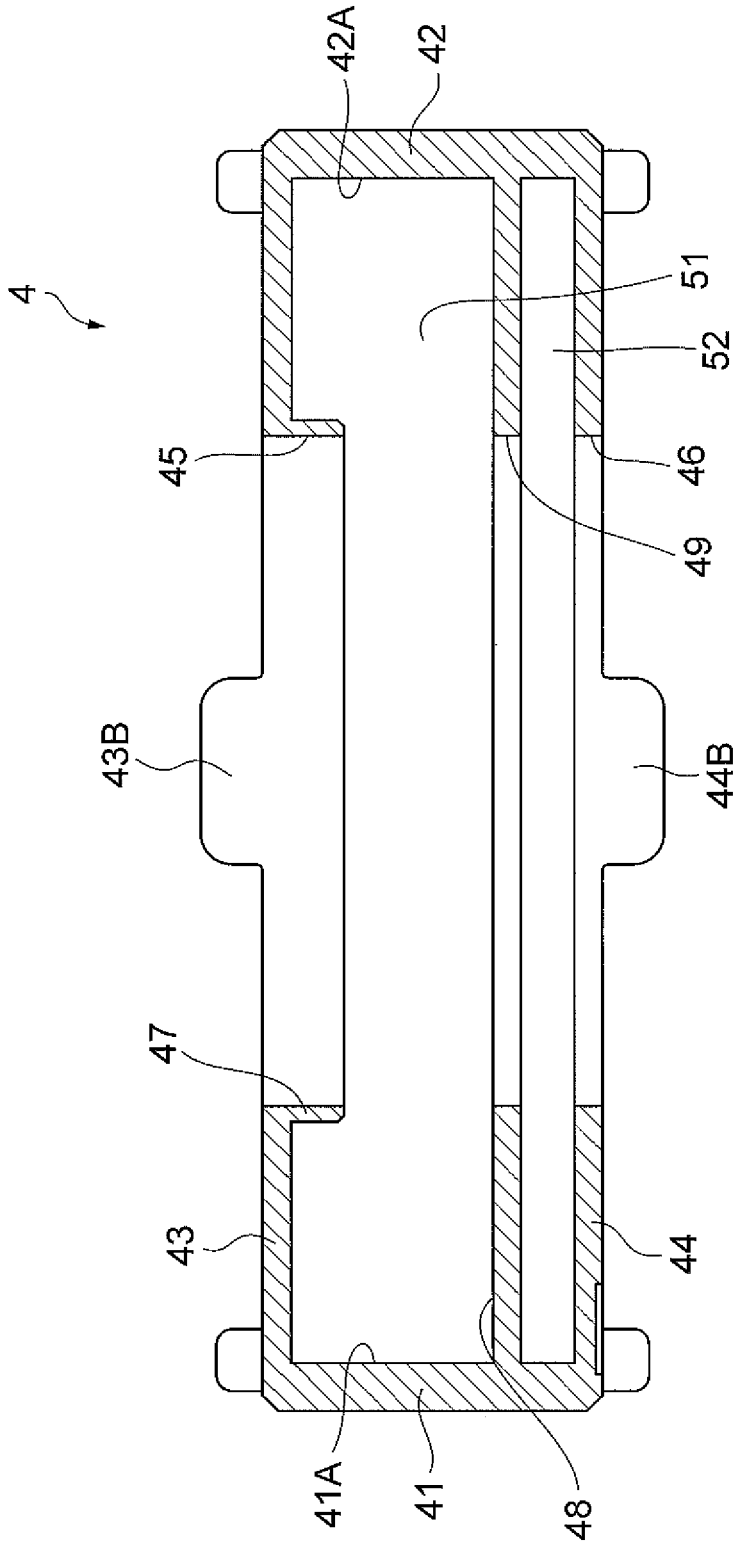


Fig.6

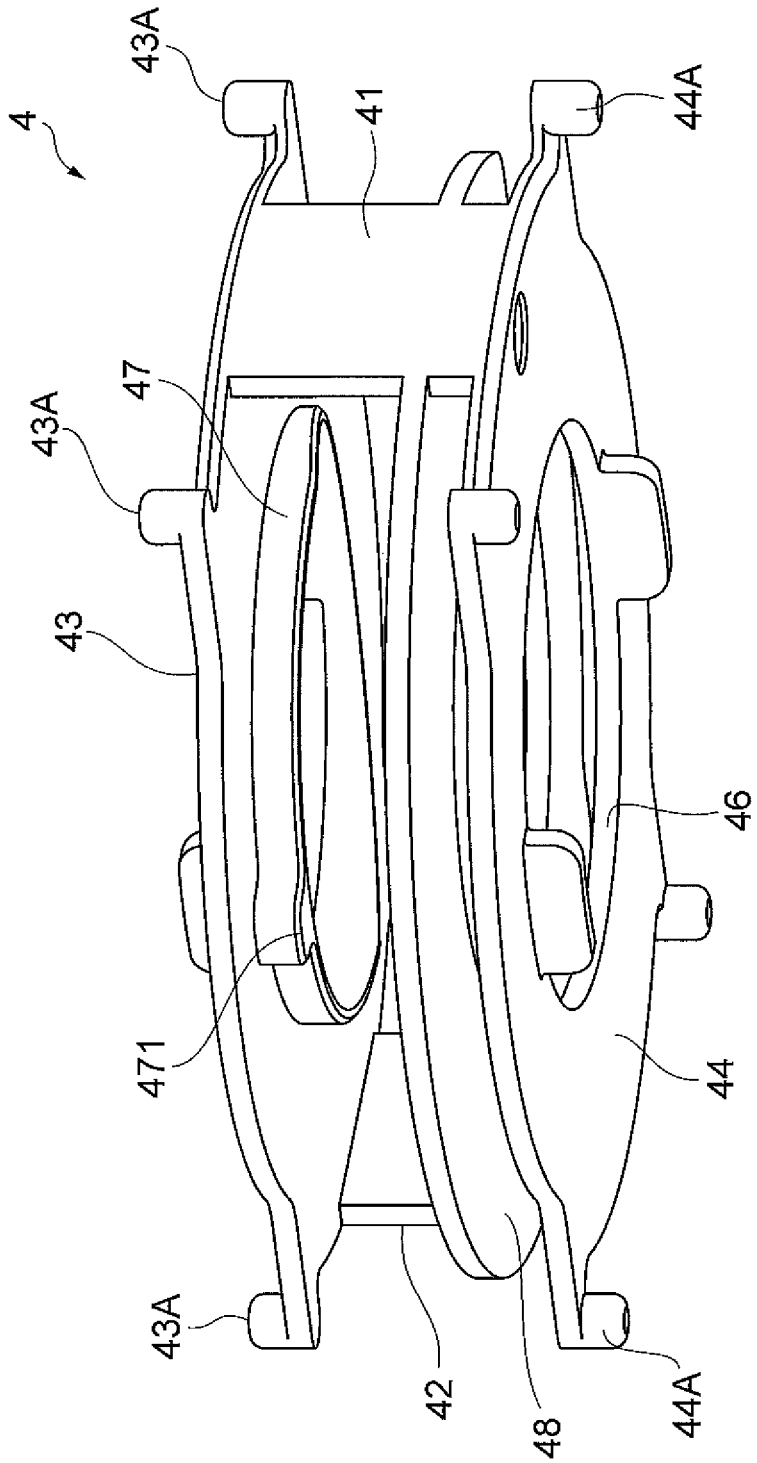


Fig.7

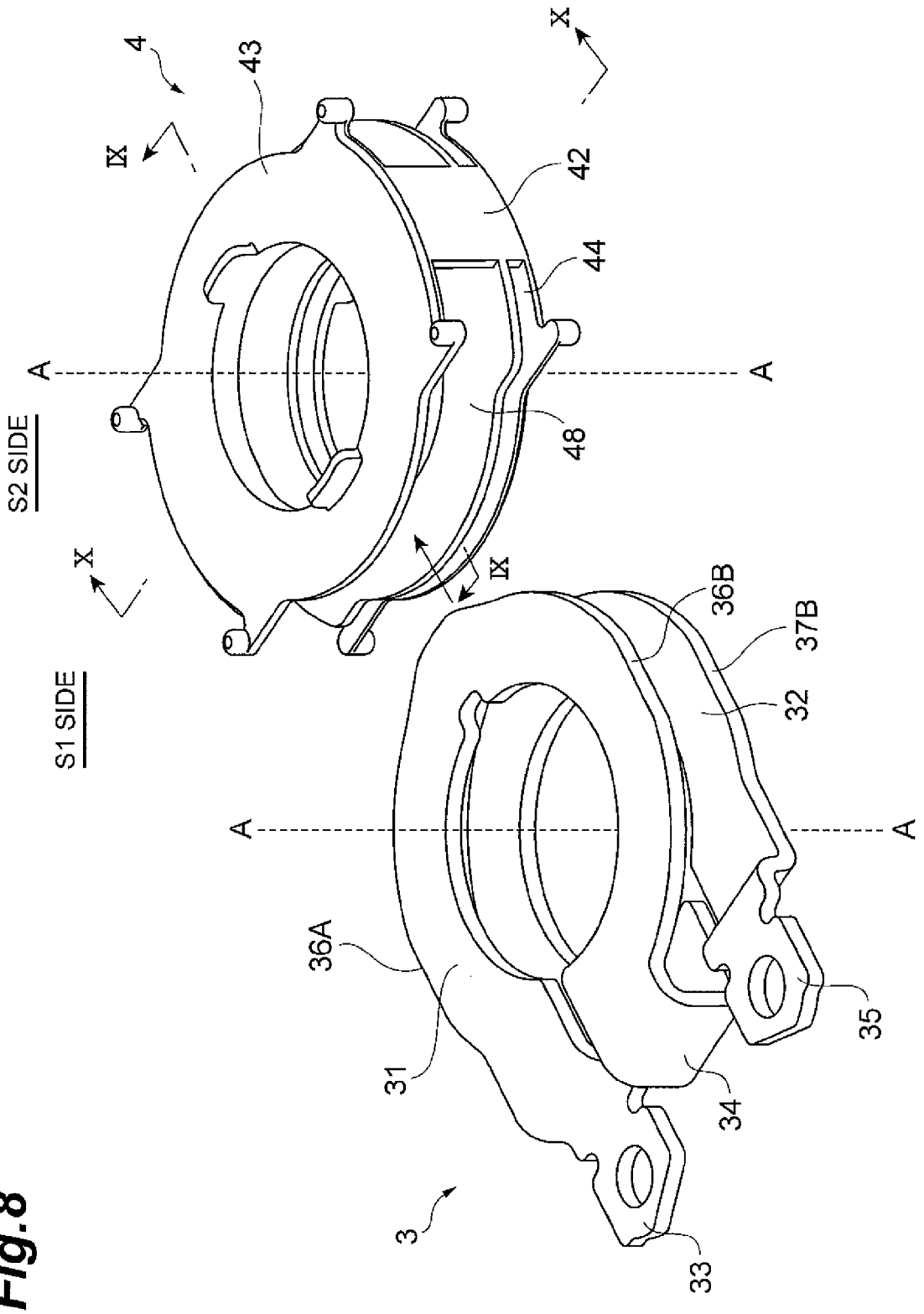

4
43
X
IX
42
44
A
A
48
S2 SIDE
X
IX
36B
37B
32
S1 SIDE
A
A
36A
31
35
34
3
33

Fig.8

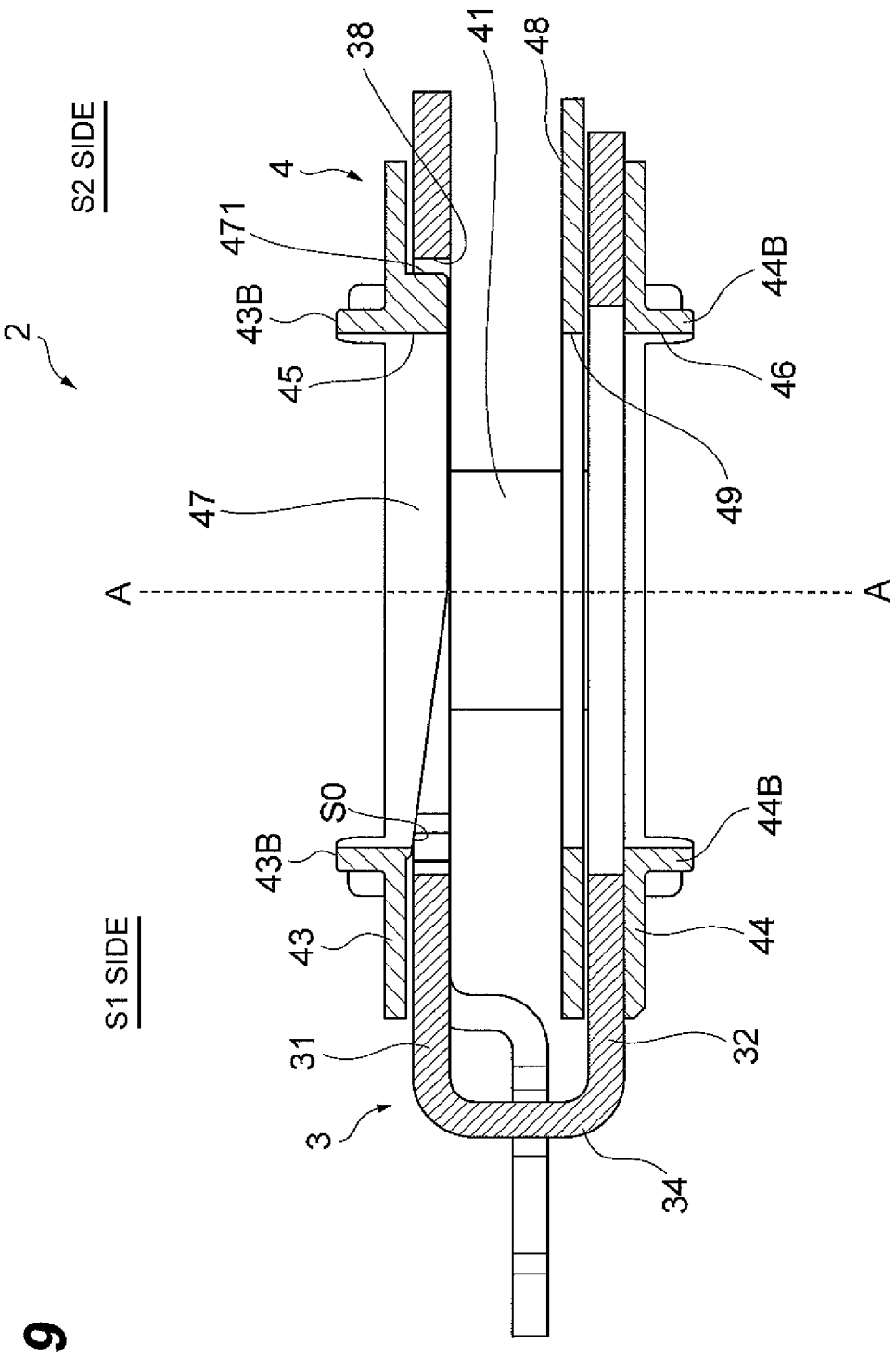

S2 SIDE
S1 SIDE
2
4
38
41
48
471
43B
45
44B
46
49
47
A
A
S0
43B
44B
43
44
31
32
3
34

Fig.9

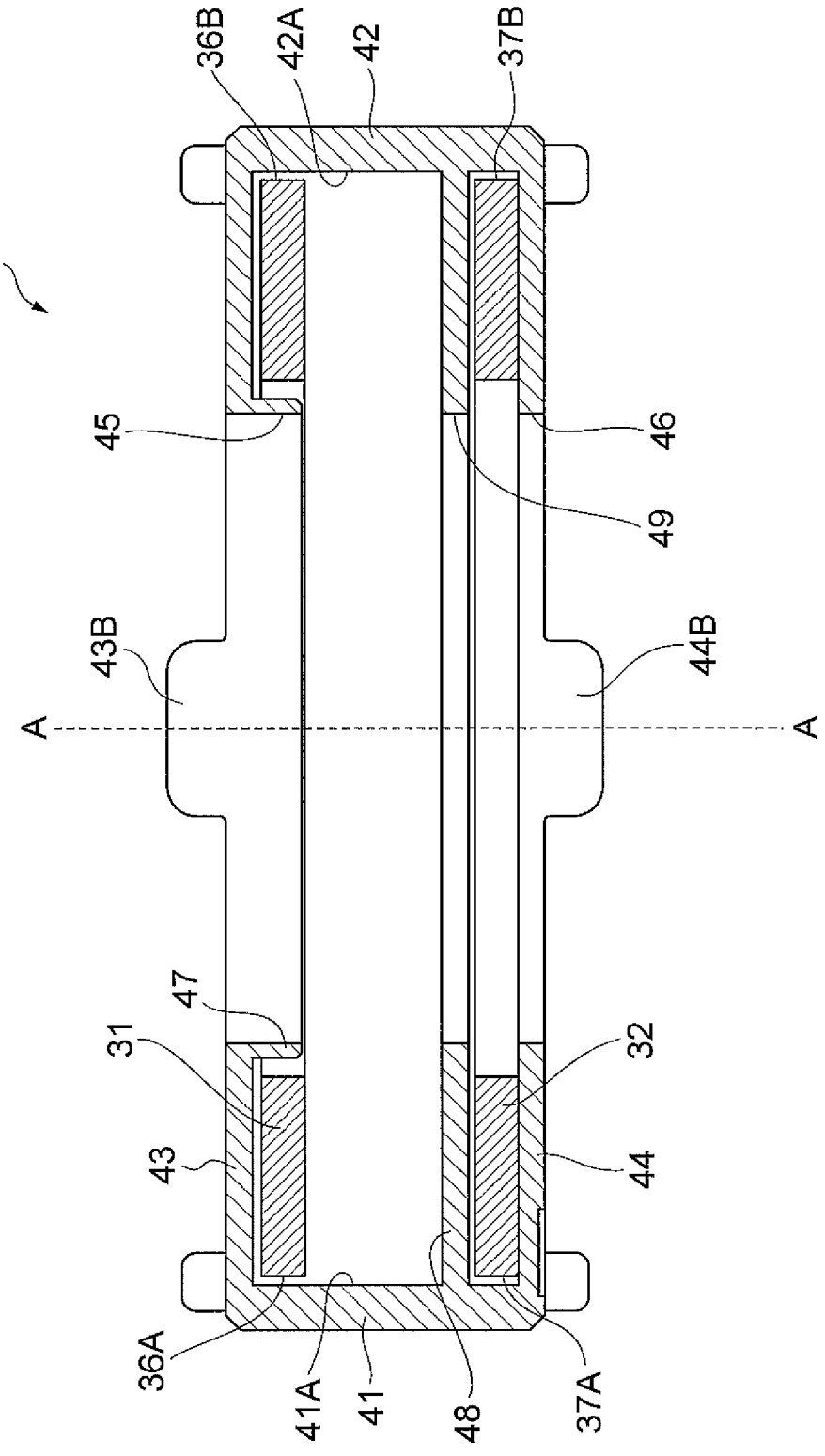


Fig.10

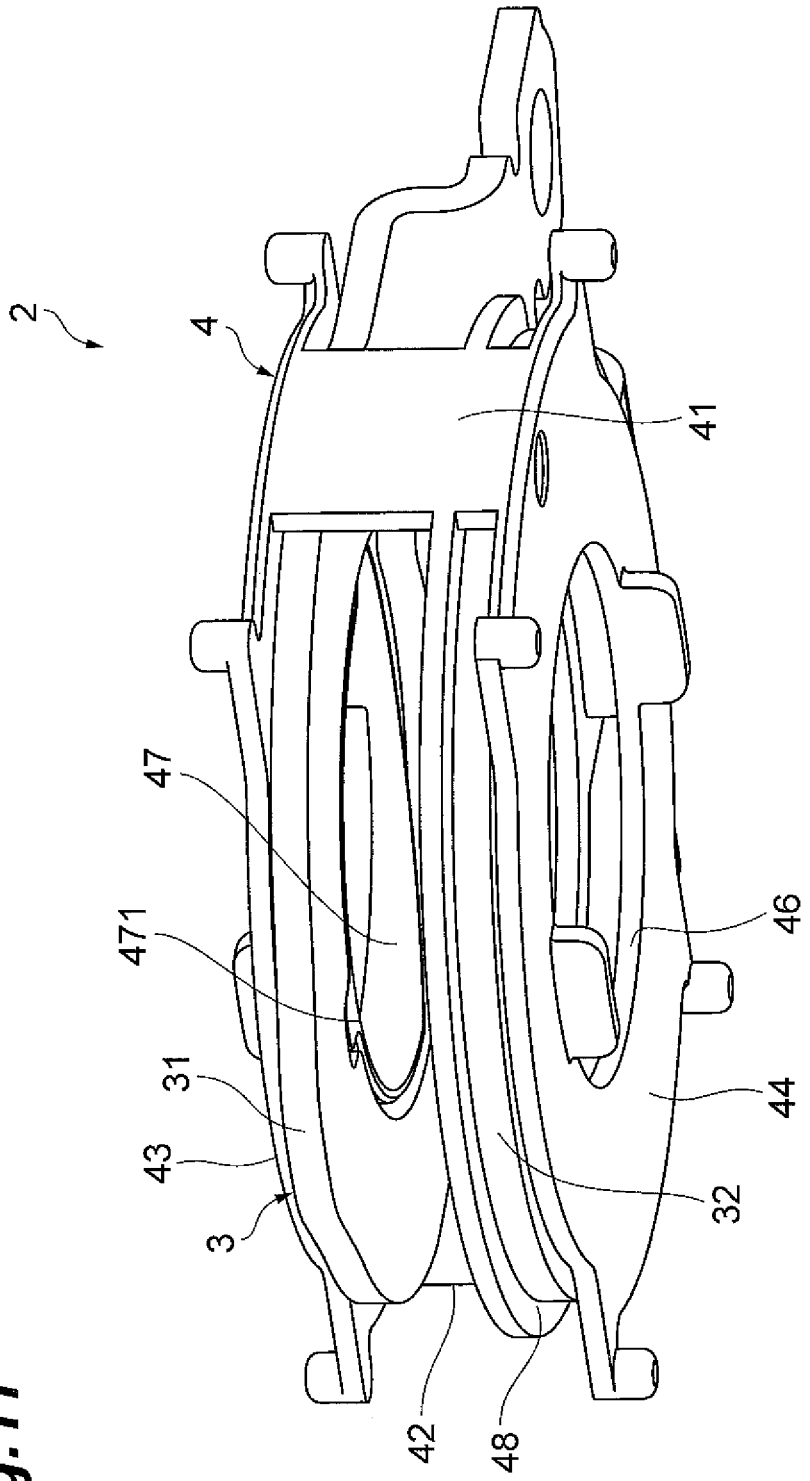


Fig.11

BOBBIN AND COIL COMPONENT

TECHNICAL FIELD

The present invention relates to a bobbin and a coil component with the bobbin.

BACKGROUND

A coil winding wire that is used in a transformer of a switching power supply device assembled in an in-car battery charger or the like needs to be insulated from other electronic components. As a coil bobbin used for the insulation, for example, Japanese Patent Application Laid-Open No. 2010-45187 discloses a coil bobbin of which a main body portion is inserted into a coil winding wire and which has a protrusion portion protruding outward from the outer peripheral surface of the main body portion.

SUMMARY

However, in the coil bobbin disclosed in Japanese Patent Application Laid-Open No. 2010-45187, a transformer core inserted into a winding shaft of the coil winding wire is insulated and the transformer core is insulated at the bottom surface side of the coil winding wire, but the winding wire is exposed at the other surface of the coil winding wire. For this reason, a case may be considered in which the contact between the coil winding wires and the contact between the coil winding wire and other electronic components occurring in accordance with the strength or the direction of vibration or impact cannot be easily prevented. Further, an insulation member different from the coil bobbin may be further assembled in order to prevent the contact. However, in this case, the number of components increases, and hence the number of assembling processes or the component management cost increases.

The present invention is made in view of the above-described circumstances, and an object of the present invention is to provide a bobbin capable of improving an insulation property of a coil winding wire without increasing the number of components and a coil component in which a coil winding wire is attached to the bobbin.

In order to attain the above-described object, according to an aspect of the present invention, there is provided a bobbin including: at least two insulating side wall portions that are disposed so as to face each other with an axis interposed therebetween and extend in the axis direction; a first insulating connection portion that is formed along a plane perpendicular to the axis so as to connect the same side ends in the axis extension direction among the ends of the two side wall portions and has an opening formed in a region with the axis; and a second insulating connection portion that is formed along a plane perpendicular to the axis so as to connect the opposite side ends of the ends connected by the first connection portion among the ends of the two side wall portions, wherein the first connection portion includes an inner wall portion that is formed in a surface facing the second connection portion so as to extend in the axis direction from the peripheral edge of the opening, and wherein the inner wall portion in the axis direction is inclined so that the height thereof increases from one side toward the other side.

According to the bobbin, in a case where the coil winding wire is inserted into a region formed by the two side wall portions, the first connection portion, and the second connection portion and the result is sandwiched by the cores, it is possible to prevent the two side wall portions from contacting the coil winding wire and the outer electronic component. Further, since the coil winding wire is sandwiched by the first connection portion formed at the upper surface side of the coil winding wire and the second connection portion formed at the lower surface side thereof from the upper and lower surfaces of the coil winding wire, the insulation property of the coil winding wire with respect to the other electronic components in the up and down direction is maintained. Further, it is possible to insulate the inner wall portion formed in the first connection portion from the leg portion of the transformer core inserted into the opening. In addition, since the inner wall portion is inclined so that the height thereof increases from one side toward the other side, the coil winding wire may be inserted into the bobbin along the slope of the inner wall portion, and hence the workability may be improved. In this way, according to the bobbin, it is possible to improve the insulation property of the coil winding wire without increasing the number of components.

Here, the bobbin may further include a third insulating connection portion that is formed in a plane perpendicular to the axis so as to connect the two side wall portions at a position different from both ends of the two side wall portions.

In this way, since the third insulating connection portion is further provided, for example, in a case where the coil winding wire is wound by at least two turns, when the coil winding wire is inserted so that the third connection portion is sandwiched between the adjacent winding wires, the insulation property between the winding wires may be improved.

Further, the inner wall portion may include a protrusion portion that protrudes outward.

Accordingly, it is possible to appropriately position the coil winding wire by the use of the protrusion portion formed in the inner wall portion and to suppress the movement of the coil winding wire caused by the vibration or the like.

Further, according to another aspect of the present invention, there is provided a coil component including: a coil winding wire that is wound around the axis by at least one turn; and the above-described bobbin.

Further, according to still another aspect of the present invention, there is provided a coil component including: a coil winding wire that is wound around the axis by at least one turn; and the above-described bobbin, wherein the coil winding wire is formed by connecting a plurality of plate-shaped winding wires in the axis direction, forms an annular shape when viewed from the axis direction, and has a cut portion that is formed at the inner peripheral side thereof so as to protrude outward from the axis, and wherein the shape of the cut portion corresponds to the protrusion portion that is formed in the inner wall portion of the bobbin.

As described above, in a case where the coil winding wire is provided with the cut portion corresponding to the protrusion portion formed in the inner wall portion of the bobbin, the coil winding wire and the bobbin are attached so that the cut portion and the protrusion portion are fitted to each other during the assembly. As a result, it is possible to appropriately position the coil winding wire and to prevent the movement of the coil winding wire caused by the vibration or the impact.

According to the present invention, there are provided the bobbin capable of improving the insulation property of the coil winding wire without increasing the number of components and the coil component in which the coil winding wire is attached to the bobbin.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic configuration diagram illustrating a transformer that includes a coil component according to an embodiment.

FIG. **2** is an exploded perspective view of the transformer.

FIG. **3** is a perspective view illustrating the configuration of a coil winding wire.

FIG. **4**A is a top view of a coil winding wire **3** and FIG. **4**B is a bottom view of the coil winding wire **3**.

FIG. **5**A is a top view of a bobbin and FIG. **5**B is a bottom view of the bobbin.

FIG. **6** is a diagram taken along the line VI-VI of FIG. **5**A.

FIG. **7** is a perspective view of the bobbin.

FIG. **8** is a perspective view illustrating a method of attaching the coil winding wire to the bobbin.

FIG. **9** is a diagram taken along the line IX-IX of FIG. **8** with respect to the attached coil component.

FIG. **10** is a diagram taken along the line X-X of FIG. **8** with respect to the attached coil component.

FIG. **11** is a perspective view of the coil component.

DETAILED DESCRIPTION

Hereinafter, preferred embodiments of the present invention will be described in detail by referring to the accompanying drawings. Furthermore, the same reference numerals will be given to those of the same components in the description of the drawings, and the description thereof will not be repeated.

(Configuration of Transformer with Coil Component)

Referring to FIGS. **1** and **2**, the configuration of a coil component and a bobbin included in the coil component according to the embodiment will be described. FIG. **1** is a schematic configuration diagram illustrating a transformer with the coil component according to the embodiment, and FIG. **2** is an exploded perspective view of the transformer.

A transformer **1** illustrated in FIG. **1** is used in an inductance element, a switching power supply device, a noise filter, an inverter, and the like. The transformer **1** includes a coil component **2** and a pair of magnetic core members **6**A and **6**B. Further, the coil component **2** includes a coil winding wire **3** and a bobbin **4**. The coil winding wire **3** has a configuration in which annular plate-shaped winding members with ends are disposed in parallel with a gap therebetween and are connected to each other in a predetermined direction along the axis A of FIG. **2**, and is inserted into the bobbin **4**.

Hereinafter, the respective components constituting the transformer **1** will be described, and a method of assembling the transformer **1** will be described.

(Coil Winding Wire)

The coil winding wire **3** will be described by referring to FIGS. **3**, **4**A, and **4**B. FIG. **3** is a perspective view illustrating the configuration of the coil winding wire **3**, FIG. **4**A is a top view of the coil winding wire **3**, and FIG. **4**B is a bottom view of the coil winding wire **3**.

As illustrated in FIGS. **3**, **4**A, and **4**B, the coil winding wire **3** connects two winding members **31** and **32**, which are substantially formed in annular shapes with ends and are disposed in parallel with a gap therebetween, in a predetermined direction. The winding members **31** and **32** each having an annular shape with ends substantially form a C-shape and have circular openings **301** and **302** formed at the center portions thereof. The winding member **31** and the winding member **32** overlap each other so that the openings **301** and **302** communicate with each other. Further, the winding member **31** and the winding member **32** are respectively formed as one-turn winding wires, and slits **303** and **304** are respectively formed between one end and the other end so as to extend from the inner periphery to the outer periphery.

Further, one end of the winding member **31** is integrally provided with a first terminal portion **33** that protrudes outward from the axis A (see FIG. **3**) of the opening **301**. Then, the other end of the winding member **31** is connected to one end of the winding member **32** through a U-shaped connection portion **34**. The other end of the winding member **32** is integrally provided with a second terminal portion **35** that protrudes outward from the axis A of the opening **302**.

In the coil winding wire **3** with the above-described configuration, the first terminal portion **33** becomes a starting end of the coil winding wire **3**, and the second terminal portion **35** becomes a dead end of the coil winding wire **3**. Then, when a current is input to the first terminal portion **33**, the current flows in order of the winding member **31**, the connection portion **34**, and the winding member **32** and is output from the second terminal portion **35**.

The outer periphery of the winding member **31** of the coil winding wire **3** is provided with notch portions **36**A and **36**B that are formed by cutting a part of the outer periphery in a linear shape. Similarly, the outer periphery of the winding member **32** is also provided with notch portions **37**A and **37**B that are formed by cutting a part of the outer periphery in a linear shape. As illustrated in FIGS. **4**A and **4**B, the notch portion **36**A formed in the winding member **31** and the notch portion **37**A formed in the winding member **32** overlap each other in a top view. Similarly, the notch portion **36**B formed in the winding member **31** and the notch portion **37**B formed in the winding member **32** overlap each other in a top view. Further, the notch portions **36**A and **36**B and the notched portions **37**A and **37**B are respectively formed at positions with the axis A interposed therebetween so that the respective end surfaces are parallel to one another. Since the coil winding wire **3** is provided with the notch portions **36**A, **36**B, **37**A, and **37**B, the distance (the distance between the notch portions **37**A and **37**B) between the notch portions **36**A and **36**B becomes the minimum diameter of the winding member **31** (**32**). That is, the distance (the distance between the notch portions **37**A and **37**B) between the notch portions **36**A and **36**B becomes the minimum diameter of the coil winding wire **3**.

Further, the inner peripheral edge of the winding member **31** of the coil winding wire **3** is provided with a cut portion **38** that is cut outward from the axis A. The cut portion **38** has a predetermined width along the peripheral edge of the opening **301** and a predetermined depth in the radial direction of the opening **301**, and is formed so as to penetrate the winding member **31** in the thickness direction.

Then, since the cut portion **38** is formed, the cross-sectional area of the winding member **31** in a cross-section perpendicular to the current flowing direction around the cut portion **38** decreases, and hence the electrical resistance may increase. Since an increase in electrical resistance may generate heat or the like, there is a need to prevent an increase in electrical resistance. Therefore, in the embodiment, an outer peripheral edge **39** corresponding to the region provided with the cut portion **38** protrudes outward, so that the width of the winding member **31** in the region provided with the cut portion **38** is ensured, and hence an increase in electrical resistance caused by a decrease in the cross-sectional area of the winding member **31** defined by the width and the thickness is suppressed.

The coil winding wire **3** with the above-described configuration may be formed by punching one plate member having high electrical conductivity. More specifically, the first terminal portion **33**, the winding member **31** that is continuous to the first terminal portion **33**, the second terminal portion **35** that is continuous to the winding member **32**, the winding member **32** that is continuous to the second terminal portion **35**, and the I-shaped connection portion **34** that connect the

winding members **31** and **32** to each other are obtained by punching a plate member such as a copper plate and an aluminum plate. Then, the connection portion **34** is bent in a U-shape so that the winding members **31** and **32** overlap each other with a predetermined gap therebetween. Accordingly, the coil winding wire **3** is finally formed by the conductive plate. Furthermore, the coil winding wire **3** is not limited to the bent coil. For example, the coil member and the connection portion may be screw-clamped or welded to each other. Further, the coil member and the connection portion may be fixed to each other by a rivet.

(Bobbin)

Next, the configuration of the bobbin **4** will be described by referring to FIGS. **5**A to **7**. FIG. **5**A is a top view of the bobbin **4**, FIG. **5**B is a bottom view of the bobbin **4**, FIG. **6** is a diagram taken along the line VI-VI of FIG. **5**A, and FIG. **7** is a perspective view of the bobbin **4**.

As illustrated in FIGS. **5**A to **7**, the bobbin **4** includes two side wall portions **41** and **42** that extend in the direction (the up and down direction of FIG. **2**) of the axis A of the coil winding wire **3** and are disposed so as to face each other with the axis A interposed therebetween, a connection portion **43** (a first connection portion) that connects the upper ends of the side wall portions **41** and **42** as illustrated in the drawings, and a connection portion **44** (a second connection portion) that connects the lower ends of the side wall portions **41** and **42** as illustrated in the drawings. The side wall portions **41** and **42** and the connection portions **43** and **44** are formed of an insulating material.

The side wall portions **41** and **42** of the bobbin **4** are formed by the members that substantially have flat plate shapes or the same shapes, and are formed so that the length directions thereof become the direction of the axis A of the coil winding wire **3**. More specifically, in the side wall portions **41** and **42**, the surfaces near the axis A are flat, but the outer peripheral side surfaces opposite to the surfaces near the axis A are gently curved so as to form a circular-arc shape when viewed from the direction of the axis A. Further, the distance between an inner surface **41**A of the side wall portion **41** and an inner surface **42**A of the side wall portion **42** is set based on the distance (the distance between the notch portions **37**A and **37**B) between the notch portions **36**A and **36**B as the minimum diameter of the coil winding wire **3**.

Further, the connection portions **43** and **44** are formed by the members having flat plate shapes, are formed in annular shapes having openings **45** and **46** formed at the center portions thereof, and extend in a direction perpendicular to the axis A. The openings **45** and **46** are formed so that the openings communicate with the opening of the coil winding wire **3** and the leg portion of the magnetic core member **6**A is insertable into the opening when attaching the coil winding wire **3** to the bobbin **4**. Furthermore, the inner diameters of the openings **45** and **46** of the bobbin **4** are set to be smaller than the inner diameter of the opening formed in the coil winding wire **3**.

The connection portion **43** of the bobbin **4** is provided with an inner wall portion **47** that extends along the axis A from the inner peripheral edge toward the connection portion **44** disposed at the facing position (where the inner wall portion is indicated by the dashed line in FIG. **5**A). The inner wall portion **47** is substantially formed in a substantially annular shape along the peripheral edge of the opening **45**. The height of the inner wall portion **47**, that is, the length in the direction of the axis A at the lower surface side of the connection portion **43** changes along the peripheral edge of the opening **45** as illustrated in FIG. **7**. More specifically, the height of the inner wall portion **47** increases from one side (the side indicated by S**1** in FIG. **5**A) with respect to the line (the line S in FIG. **5**A) connecting the centers of the connection portion **43** and the connection portion **44** toward the other side (the side indicated by S**2** in FIG. **5**A). Then, in the region S**0** which is farthest from the line S at the side S**1** of the inner wall portion **47**, the height of the inner wall portion **47** is lowest, and the height of the inner wall portion **47** with respect to the lower surface of the connection portion **43** is very low. The height of the region S**0** of the inner wall portion **47** may be zero. The slope of the inner wall portion **47** may cause the coil winding wire **3** to be easily inserted into the bobbin **4** when attaching the coil winding wire **3** to the bobbin **4** and prevent the coil winding wire **3** from being separated from the bobbin **4** after attaching the coil winding wire **3** to the bobbin **4**. The detail description will be made later.

The width of the inner wall portion **47** that is formed in the connection portion **43** of the bobbin **4** is set to be smaller than a difference between the inner diameter of the opening **45** and the inner diameter of the opening **301** formed in the coil winding wire **3**, and is substantially uniform along the peripheral edge of the opening **45**. However, a protrusion portion **471** is provided which has a width larger than those of the other regions only in a region of a predetermined length. The length and the depth (width) of the protrusion portion **471** may be defined in correspondence to the cut portion **38** formed in the coil winding wire **3**. That is, the protrusion portion **471** is fitted to the cut portion **38** when attaching the coil winding wire **3** to the bobbin **4**. Accordingly, it is possible to prevent the rotation of the coil winding wire **3** after attaching the coil winding wire **3** to the bobbin **4**. The detail description will be made later.

Further, an intermediate plate portion **48** (a third connection portion) is further provided which connects the inner peripheral surface **41**A near the axis A in the side wall portion **41** of the bobbin **4** to the inner surface **42**A near the axis A in the side wall portion **42**. The intermediate plate portion **48** is formed by a flat plate-shaped member as in the connection portions **43** and **44**, forms an annular shape having an opening **49** formed at the center portion thereof, and is formed so as to be parallel to the connection portions **43** and **44**. The distance between the intermediate plate portion **48** and the connection portion **44** is set to a thickness in which the winding member of the coil winding wire **3** may be inserted between the intermediate plate portion **48** and the connection portion **44**. That is, the intermediate plate portion **48** is used as a winding wire guide that appropriately places the coil winding wire **3** to a predetermined position inside the bobbin **4** when attaching the coil winding wire **3** to the bobbin **4** and is used to prevent the contact and the short-circuit between the winding members of the coil winding wire **3** after the placement.

As in the openings **45** and **46**, the opening **49** is formed in the intermediate plate portion **48** of the bobbin **4** so that the opening communicates with the opening of the coil winding wire **3** and the leg portion of the magnetic core member **6**A is insertable into the opening when attaching the coil winding wire **3** to the bobbin **4**. Furthermore, the inner diameter of the opening **49** of the bobbin **4** is smaller than the inner diameter of the opening formed in the coil winding wire **3**.

Further, the connection portions **43** and **44** of the bobbin **4** are integrally provided with guide portions **43**A and **44**A that protrude outward with respect to the axis A. Further, the connection portion **43** of the bobbin **4** is provided with a second guide portion **43**B that extends upward from the upper surface thereof in the direction of the axis A. Further, the connection portion **44** of the bobbin **4** is provided with a second guide portion **44**B that extends downward from the lower surface (the bottom surface) thereof in the direction of

the axis A. The guide portions **43**A and **44**A and the second guide portions **43**B and **44**B prevent the magnetic core member **6**A from being moved by the vibration or the like when attaching the magnetic core members **6**A and **6**B to the coil component **2**. The detail description will be made later.

Further, as illustrated in FIG. **6**, the region that is surrounded by the side wall portions **41** and **42**, the connection portion **43**, and the intermediate plate portion **48** forms an opening **51** that has a substantially rectangular shape in a side view. Further, the region that is surrounded by the side wall portions **41** and **42**, the connection portion **44**, and the intermediate plate portion **48** forms an opening **52** that has a substantially rectangular shape in a side view. At this time, it is desirable that the distance between the side wall portion **41** and the side wall portion **42** be substantially equal to the minimum diameter of the coil winding wire **3**.

As an insulating material of forming the bobbin **4**, for example, a PBT (Poly Butylene Terephthalate) resin or a PPS (Poly Phenylene Sulfide) resin is appropriately used due to the excellent properties such as heat resistance, chemical resistance, flame resistance, and dimensional stability.

(Attachment of Coil Winding Wire with Respect to Bobbin)

Next, the attachment of the coil winding wire **3** with respect to the bobbin **4** will be described by referring to FIGS. **8** to **11**. FIG. **8** is a perspective view illustrating a method of attaching the coil winding wire **3** to the bobbin **4**. Further, FIG. **9** is a diagram taken along the line IX-IX of FIG. **8** with respect to the attached coil component, and FIG. **10** is a diagram taken along the line X-X of FIG. **8** with respect to the attached coil component. Further, FIG. **11** is a perspective view of the coil component.

As illustrated in FIG. **8**, when attaching the coil winding wire **3** to the bobbin **4**, the coil winding wire **3** is inserted into the openings (the openings **51** and **52** of FIG. **6**) respectively surrounded by the side wall portions **41** and **42** and the connection portions **43** and **44** of the bobbin **4** in a direction from the front side in the drawing toward the inner side in the drawing, that is, a direction from the side S**1** of the bobbin **4** toward the side S**2**. At this time, the coil winding wire **3** is set to a direction in which the communication directions of the openings **45**, **46**, and **49** of the bobbin **4** matches the axis of the coil winding wire **3** and the notch portions **36**A, **36**B, **37**A, and **37**B of the coil winding wire **3** are disposed in the extension direction of the inner surfaces of the side wall portions **41** and **42**. Then, the coil winding wire **3** is inserted to a position where the inner surface **41**A of the side wall portion **41** faces the notch portions **36**A and **37**A and the inner surface **42**A of the side wall portion **42** faces the notch portions **36**B and **37**B.

At this time, even when the insertion direction of the coil winding wire **3** with respect to the bobbin **4** is changed by rotating the coil winding wire **3** about the axis A, the coil winding wire **3** may not be inserted into the bobbin because the distance between the side wall portions **41** and **42** is smaller than the diameter of the coil winding wire **3**. Specifically, for example, even when there is an attempt to insert the coil winding wire **3** into the bobbin while forming an angle of 45° by the notch portions **36**A, **36**B, **37**A, and **37**B and the inner surfaces **41**A and **42**A of the side wall portions **41** and **42** by rotating the coil winding wire about the axis A by 45°, the coil winding wire **3** may not be inserted between the inner surfaces **41**A and **42**A of the side wall portions **41** and **42** formed in correspondence with the distance between the notch portions **36**A and **36**B because the diameter of the winding member **31** in the region without the notch portions **36**A and **36**B is larger than the distance (the distance between the notch portions **37**A and **37**B) between the notch portions **36**A and **36**B.

When inserting the coil winding wire **3** into the bobbin **4**, the winding member **31** is inserted into the opening **51** of the bobbin **4**, and the winding member **32** is inserted into the opening **52** of the bobbin **4**. That is, the bobbin **4** is attached so that the intermediate plate portion **47** is sandwiched between the winding member **31** and the winding member **32**.

Here, since the inner wall portion **47** that is formed in the peripheral edge of the opening **45** of the connection portion **43** is formed in a substantially annular shape, it is considered that the coil winding wire **3** may not be easily inserted because the inner wall portion **47** is caught by the winding member **31** of the coil winding wire **3**. However, in the bobbin **4** of the embodiment, the inner wall portion **47** is inclined so that the height thereof increases from the region S**0** at the side S**1** toward the side S**2**. Accordingly, the height of the inner wall portion **47** contacting the winding member **31** gradually increases from the region S**0** as the coil winding wire **3** is inserted into the bobbin **4**. Accordingly, the coil winding wire **3** may be inserted into the bobbin **4** while the winding member **31** of the coil winding wire **3** is bent downward about the connection portion **34**.

Then, when the coil winding wire **3** is inserted to a position where the communication direction of the openings **45**, **46**, and **49** of the bobbin **4** matches the axis of the coil winding wire **3**, the protrusion portion **471** that is formed in the inner wall portion **47** is inserted into the corresponding cut portion **38** of the coil winding wire **3** as illustrated in FIGS. **9** and **11**. Accordingly, the downward bent state of the winding member **31** of the coil winding wire **3** returns to the original state, and the bobbin **4** is attached to a predetermined position of the coil winding wire **3** as illustrated in FIGS. **9** and **10**, thereby forming the coil component **2**.

After assembling the coil winding wire **3** and the bobbin **4** as the coil component **2**, a variation in the positional relation between the coil winding wire **3** and the bobbin **4** is suppressed. For example, since the winding member **32** of the coil winding wire **3** is sandwiched between the connection portion **44** and the intermediate plate portion **48** and the upper surface of the winding member **31** contacts the connection portion **43**, the movement of the coil winding wire **3** in the direction of the axis A is suppressed. Further, since the inner wall portion **47** of the bobbin **4** is fitted into the opening **301** of the winding member **31**, the movement of the coil winding wire **3** in a plane direction perpendicular to the axis A is suppressed. Moreover, since the cut portion **38** of the winding member **31** is fitted to the protrusion portion **471** formed in the inner wall portion **47** of the bobbin **4**, the rotation of the coil winding wire **3** about the axis A is suppressed. In addition, since the distance between the side walls **41** and **42** is set based on the distance (the distance between the notch portions **37**A and **37**B) between the notch portions **36**A and **36**B as the minimum diameter of the coil winding wire **3**, the rotation of the coil winding wire **3** is also suppressed by the side walls **41** and **42**.

Further, the outer peripheral edge **39** includes a portion that is located at the outside in relation to the outer periphery of the connection portion **43** in a top view when the coil winding wire **3** and the bobbin **4** are assembled as the coil component **2**. Accordingly, in a case where the coil winding wire **3** and the bobbin **4** are separated from each other so as to rework them, the fitting state between the cut portion **38** and the protrusion portion **471** is released when the outer peripheral edge **39** is pressed downward along the axis A. Further, the coil winding wire **3** and the bobbin **4** may be simply separated

from each other when the coil winding wire **3** is pressed toward the region S**0**. As a result, the disassembling workability is excellent.

(Coil Component)

Next, returning to FIGS. **1** and **2**, the transformer **1** will be described. The transformer **1** has a configuration in which the coil component **2** further includes the pair of magnetic core members **6**A and **6**B.

As illustrated in FIGS. **1** and **2**, the magnetic core members **6**A and **6**B are disposed so as to sandwich the coil component **2** along the axis A penetrating the openings of the coil winding wire **3** and the bobbin **4** constituting the coil component **2**.

The magnetic core members **6**A and **6**B are so-called E-type cores that are obtained by compacting ferrite powder. More specifically, the magnetic core member **6**A includes a base portion **60** that has a flat plate shape in the length direction, a columnar main leg **61** that protrudes from the center portion of one main surface of the base portion **60**, and two outer legs **62** and **63** that are formed in the ends of the base portion **60** with the main leg **61** interposed therebetween. Further, the magnetic core member **6**B includes a base portion **66** that has a flat plate shape in the length direction, a columnar main leg **67** that protrudes from the center portion of one main surface of the base portion **66**, and two outer legs **68** and **69** that are formed in the ends of the base portion **66** with the main leg **67** interposed therebetween.

The main leg **61** of the magnetic core member **6** is inserted so as to communicate the openings of the coil component **2**, that is, the opening **45** of the connection portion **43** of the bobbin **4**, the opening **301** of the winding member **31**, the opening **49** of the intermediate plate portion **48** of the bobbin **4**, the opening **302** of the winding member **32**, and the opening **46** of the connection portion **44** of the bobbin **4**. At this time, as illustrated in FIG. **10**, since the diameters of the opening **45** of the connection portion **43** of the bobbin **4**, the opening **49** of the intermediate plate portion **48**, and the opening **46** of the connection portion **44** are smaller than the diameters of the openings **301** and **302** of the winding members **31** and **32**, the opening **45** of the connection portion **43**, the opening **49** of the intermediate plate portion **48**, and the opening **46** of the connection portion **44** are inserted into the main leg **61** of the magnetic core member **6**A and the main leg **67** of the magnetic core member **6**B with a slight clearance formed therebetween, and the openings **301** and **302** of the winding members **31** and **32** do not contact the main leg **61** of the magnetic core member **6**A and the main leg **67** of the magnetic core member **6**B. In this way, the bobbin **4** is used to prevent the magnetic core members **6**A and **6**B from contacting the coil winding wire **3** inside the opening.

Returning to FIG. **1**, the outer legs **62** and **63** of the magnetic core member **6**A and the outer legs **68** and **69** of the magnetic core member **6**B extend in the direction of the axis A so that the outer leg **62** contacts the outer leg **68** and the outer leg **63** contacts the outer leg **69** along the side walls **41** and **42**. At this time, since the side wall portions **41** and **42** of the bobbin **4** are formed along the outer peripheral surface of the coil winding wire **3**, the side wall portions **41** and **42** serve as insulation members that prevent the magnetic core members **6**A and **6**B from contacting the coil winding wire **3**.

Further, the connection portions **43** and **44** of the bobbin **4** serve as insulation members that prevent the coil winding wire **3** from contacting the magnetic core members **6**A and **6**B when the coil component **2** is sandwiched between the pair of magnetic core members **6**A and **6**B.

In addition, the connection portions **43** and **44** of the bobbin **4** are respectively provided with the guide portions **43**A and **44**A that protrude outward, and the magnetic core members **6**A and **6**B are attached while the guide portions **43**A and **44**A contact the outer legs **62**, **63**, **68**, and **69**. At this time, the base portions **60** and **66** of the magnetic core members **6**A and **6**B are respectively sandwiched between the guide portions **43**B and **44**B. Accordingly, it is possible to suppress a positional deviation in the width direction between the magnetic core members **6**A and **6**B and the coil component **2**. Furthermore, the shapes of the guide portions **43**A, **43**B, **44**A, and **44**B are not limited to the above-described shapes, and may be appropriately changed in response to the shape of the magnetic core member. Further, the side wall portions **41** and **42** of the bobbin **4** may be provided with the guide portions.

As described above, according to the bobbin **4** and the coil component **2** including the bobbin **4** and the coil winding wire **3** of the embodiment, in a case where the coil winding wire **3** is inserted into the region formed by two side wall portions **41** and **42** and two connection portions **43** and **44** and the result is sandwiched between the magnetic core members **6**A and **6**B, it is possible to prevent the two side wall portions **41** and **42** from contacting the coil winding wire **3** and the outer electronic components. Further, since the coil winding wire **3** is sandwiched between the connection portion **43** formed at the upper surface side of the coil winding wire **3** and the connection portion **44** formed at the lower surface side thereof from the upper and lower surfaces of the coil winding wire **3**, the insulation property of the coil winding wire with respect to the other electronic components in the up and down direction is also maintained. Further, the inner wall portion **47** that is formed along the opening **45** of the connection portion **43** may be insulated from the leg portions of the magnetic core members **6**A and **6**B inserted into the opening **45**. In addition, since the inner wall portion **47** is inclined so that the height thereof increases from one side (the side S**1**) facing the line S connecting the centers of the two side wall portions **41** and **42** toward the other side (the side S**2**), the coil winding wire **3** may be inserted into the bobbin **4** along the slope of the inner wall portion **47**, and hence the workability is improved. In this way, according to the bobbin **4** and the coil winding wire **3** of the embodiment, it is possible to improve the insulation property of the coil winding wire without increasing the number of components.

Further, since the bobbin **4** further includes the intermediate plate portion **48** as the third connection portion, it is possible to improve the insulation property between the winding members **31** and **32** by inserting the coil winding wire **3** so that the intermediate plate portion **48** is sandwiched between the winding member **31** and the winding member **32** in the coil winding wire **3** wound by two turns.

Further, since the inner wall portion **47** includes the protrusion portion **471** that protrudes outward in a direction opposite to the axis A, the coil winding wire **3** may be appropriately positioned by the use of the protrusion portion **471**. Specifically, since the coil winding wire **3** is provided with the cut portion **38** corresponding to the protrusion portion **471** of the inner wall portion **47** of the bobbin **4**, when the coil winding wire **3** and the bobbin **4** are assembled so that the cut portion **28** and the protrusion portion **471** are fitted to each other during the assembly, it is possible to appropriately position the coil winding wire **3** and to prevent the movement of the coil winding wire **3** caused by the vibration or the impact.

While the embodiment of the present invention has been described, the present invention is not limited to the above-described embodiment and may be modified into various forms.

For example, the shapes of the side wall portions **41** and **42**, the connection portions **43** and **44**, and the intermediate plate portion **48** formed in the bobbin **4** may be appropriately

changed. For example, in the bobbin **4** that constitutes the coil component **2** according to the embodiment, a case has been described in which the connection portions **43** and **44** and the intermediate plate portion **48** are all formed in an annular shape, but the connection portion **44** and the intermediate plate portion **48** other than the connection portion **43** provided with the inner wall portion **47** may not be formed in an annular shape, and may be formed as, for example, a rectangular member. That is, the shapes of the connection portions **43** and **44** are not limited to the above-described shapes as long as the connection portions are used to connect the ends of the side wall portions **41** and **42**. The "ends" mentioned herein indicate the vicinity of the edges of the side wall portions **41** and **42**. Specifically, the side wall portions **41** and **42** may be connected by the connection portions **43** and **44** at the inside of the edges of the side wall portions **41** and **42**.

Further, in the embodiment, a case has been described in which the coil winding wire **3** is wound by at least two turns, but the number of turning the coil winding wire may be increased. In this case, the bobbin **4** may further include an insulation member that prevents the contact between the same winding wires in response to the number of turns of the coil winding wire.

Further, the protrusion portion **471** that is formed in the inner wall portion **47** of the bobbin **4** is not essentially needed in the bobbin **4**. Further, in a case where the protrusion portion **471** is not formed in the inner wall portion **47** of the bobbin **4**, the coil winding wire **3** does not need to be provided with the cut portion **38**.

Further, in the above-described embodiment, a case has been described in which the connection portions **43** and **44** of the bobbin **4** are formed in annular shapes, but the shapes of the connection portions **43** and **44** are not limited to the above-described shapes as long as the connection portions are used to connect the ends of the side wall portions **41** and **42**. The "ends" mentioned herein indicate the vicinity of the edges of the side wall portions **41** and **42**. That is, the side wall portions **41** and **42** may be connected by the connection portions **33** and **34** at the inside of the edges of the side wall portions **41** and **42**.

Further, in the coil component **2** of the above-described embodiment, a configuration has been described in which one coil winding wire as the coil winding wire **3** is attached to the bobbin **4**, but the number of the coil winding wires may be two or more and the number of winding the coil winding wire may be one turn or more. Furthermore, the shape of the winding member forming the coil winding wire is not limited to the annular shape with ends, but may be, for example, a shape of an edgewise coil. Further, in the above-described embodiment, the annular coil winding wire has been described, but the shape of the coil winding wire may be formed in, for example, a rectangular shape in which an opening is formed at the center portion thereof. That is, the shape of the coil winding wire is not particularly limited as long as the coil winding wire may be inserted into the bobbin **4**.

Further, in the coil component **2** of the above-described embodiment, the side wall portions **41** and **42** are formed at the positions corresponding to the outer legs of the magnetic core members **6**A and **6**B, but the side wall portions **41** and **42** may be formed at different positions from this arrangement.

Further, in the bobbin **4** of the above-described embodiment, the inner wall portion **47** is inclined so that the height thereof gradually increases from the region **S0** at the side **S1** toward the side **S2** as a whole, but the present invention is not limited thereto. For example, only a part of the inner wall portion **47** may increase in height from one side toward the other side. As such a configuration, for example, a configuration may be exemplified in which the inner wall portion is formed flatly from the region **S0** toward the middle of the region **S1** and is inclined at an angle larger than the inclination angle of the embodiment therefrom. That is, a part of the inner wall portion **47** from the region **S0** toward the middle of the side **S1** is inclined and the other side **S1** or the side **S2** is formed flatly. Further, the inner wall portion may be increased in height so as to be inclined at an inclination gentler than that of the embodiment from the side **S0** toward the side **S2**.

Further, the shapes of the pair of magnetic core members **6**A and **6**B are not limited to the so-called EE-shape illustrated in the above-described embodiment. As other shapes of the core member, for example, an BE-shape, an UI-shape, and the like may be exemplified. Further, an air core without a main leg and an outer leg may be used.

Further, in the above-described embodiment, a case has been described in which the coil component **2** is used in the transformer **1**, but the coil component according to the embodiment may be applied to other electronic components such as a choke coil.

What is claimed is:

1. A bobbin comprising:

at least two insulating side wall portions that are disposed so as to face each other with an axis interposed therebetween and extend in the axis direction;

a first insulating connection portion that is formed along a plane perpendicular to the axis so as to connect the same side ends in the axis extension direction among the ends of the two side wall portions and has an opening formed in a region with the axis; and

a second insulating connection portion that is formed along a plane perpendicular to the axis so as to connect the opposite side ends of the ends connected by the first connection portion among the ends of the two side wall portions,

wherein the first connection portion includes an inner wall portion that is formed in a surface facing the second connection portion so as to extend in the axis direction from the peripheral edge of the opening, and

wherein the inner wall portion in the axis direction is inclined so that the height thereof increases from one side toward the other side.

2. The bobbin according to claim **1**, further comprising:

a third insulating connection portion that is formed in a plane perpendicular to the axis so as to connect the two side wall portions at a position different from both ends of the two side wall portions.

3. A coil component comprising:

a coil winding wire that is wound around the axis by at least one turn; and

the bobbin according to claim **2**.

4. The bobbin according to claim **2**,

wherein the inner wall portion includes a protrusion portion that protrudes outward.

5. The bobbin according to claim **1**,

wherein the inner wall portion includes a protrusion portion that protrudes outward.

6. A coil component comprising:

a coil winding wire that is wound around the axis by at least one turn; and

the bobbin according to claim **5**,

wherein the coil winding wire is formed by connecting a plurality of plate-shaped winding wires in the axis direction, forms an annular shape when viewed from the axis

direction, and has a cut portion that is formed at the inner peripheral side thereof so as to protrude outward from the axis, and

wherein the shape of the cut portion corresponds to the protrusion portion that is formed in the inner wall portion of the bobbin.

7. A coil component comprising:

a coil winding wire that is wound around the axis by at least one turn; and

the bobbin according to claim **1**.

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